

What is Claimed Is:

1. A cathode sputtering apparatus adapted for forming a uniform thickness layer of a selected material on at least one surface of at least one substrate/workpiece in a multi-stage process comprising deposition of a plurality of sub-layers, comprising:

- 5 (a) a first group of spaced-apart cathode/target assemblies; and
 (b) means for transporting at least one substrate/workpiece past each cathode/target assembly of said first group of cathode/target assemblies for deposition of a first plurality of sub-layers on a first surface of said at least one substrate/workpiece; wherein:

10 (i) each cathode/target assembly of said first group of cathode/target assemblies comprises a sputtering surface oriented substantially parallel to said first surface of said at least one substrate/workpiece; and

15 (ii) said first group of cathode/target assemblies is adapted to provide sub-layers with different sputtered film thickness profiles, such that said first plurality of sub-layers collectively form said uniform thickness layer of said selected material.

2. The apparatus as in claim 1, further comprising:

- (c) a second group of spaced-apart cathode/target assemblies opposite said first group of spaced-apart cathode/target assemblies and adapted for forming a uniform thickness layer of said selected material on a second surface of said at
 5 least one substrate/workpiece in a multi-stage process comprising deposition of a second plurality of sub-layers, wherein:

(i) each cathode/target assembly of said second group of cathode/target assemblies comprises a sputtering surface oriented

10 substantially parallel to said second surface of said at least one substrate/workpiece;

(ii) said second group of cathode/target assemblies is adapted to provide sub-layers with different sputtered film thickness profiles, such that said second plurality of sub-layers collectively form said uniform thickness layer of said selected material on said second surface of said at least one substrate/workpiece; and

(iii) said means for transporting said at least one substrate/workpiece past each cathode/target assembly of said first group of cathode/target assemblies further comprises means for transporting said at least one substrate/workpiece past each cathode/target assembly of said second group of cathode/target assemblies for deposition of said second plurality of sub-layers on said second surface of said at least one substrate/workpiece.

3. The apparatus as in claim 2, wherein:
the cathode/target assemblies of said first and second groups of cathode/target assemblies are in substantial vertical registry.

4. The apparatus as in claim 2, wherein:
the cathode/target assemblies of said first and second groups of cathode/target assemblies are located in a single vacuum chamber.

5. The apparatus as in claim 4, wherein:
the cathode/target assemblies of said first and second groups of cathode/target assemblies form an in-line or a circular-shaped arrangement within said vacuum chamber.

6. The apparatus as in claim 2, wherein:

the cathode/target assemblies of said first and second groups of cathode/target assemblies are located in a plurality of vacuum chambers.

7. The apparatus as in claim 6, wherein:

said plurality of vacuum chambers form an in-line or a circularly-shaped arrangement of chambers.

8. The apparatus as in claim 2, wherein:

each cathode/target assembly of said first and second groups of cathode/target assemblies is a planar magnetron cathode/target assembly including a magnetron magnet means.

9. The apparatus as in claim 8, wherein:

said magnetron magnet means of at least some of said planar magnetron cathode/target assemblies are of different lengths, widths, or diameters.

10. The apparatus as in claim 2, wherein:

the sputtering surfaces of at least some cathode/target assemblies of said first and second groups of cathode/target assemblies are located at different spacings from said first and second surfaces of said at least one
5 substrate/workpiece.

11. The apparatus as in claim 2, wherein:

said means for transporting said at least one substrate/workpiece past said first and second groups of cathode/target assemblies for deposition of said first and second pluralities of sub-layers comprises means for mounting and
5 transporting at least one disk-shaped substrate/workpiece.

12. The apparatus as in claim 2, further comprising:

(d) shield means in spaced adjacency to the periphery of the sputtering surface of each cathode/target assembly.

13. A method of forming a uniform thickness layer of a selected material on at least one surface of at least one substrate/workpiece by means of a multi-stage process comprising sputter deposition of a plurality of sub-layers, comprising steps of:

5 (a) providing a multi-stage cathode sputtering apparatus comprising a first group of spaced-apart cathode/target assemblies and a means for transporting at least one substrate/workpiece past each cathode/target assembly of said first group of cathode/target assemblies, each cathode/target assembly comprising a sputtering surface oriented substantially parallel to said first surface of said at
10 least one substrate/workpiece during transport of said at least one substrate/workpiece past said first group of cathode/target assemblies, said first group of cathode/target assemblies adapted for providing different sputtered film thickness profiles; and

(b) transporting said at least one substrate/workpiece past each
15 cathode/target assembly while providing different sputtered film thickness profiles from at least some of said cathode/target assemblies, such that a first plurality of sub-layers is deposited on said first surface of said at least one substrate/workpiece which collectively form a said uniform thickness layer of said selected material.

14. The method according to claim 13, wherein:

step (a) further comprises providing a multi-stage cathode sputtering apparatus comprising a second group of spaced-apart cathode target assemblies, each comprising a sputtering surface oriented substantially parallel to a second
5 surface of said at least one substrate/workpiece during transport of said at least one substrate/workpiece past each cathode/target assembly of said second group of cathode/target assemblies, said second group of cathode/target assemblies adapted for providing different sputtered film thickness profiles; and

step (b) further comprises transporting said at least one
10 substrate/workpiece past each cathode/target assembly of said second group of
cathode/target assemblies while providing different sputtered film thickness
profiles from at least some of said cathode/target assemblies, such that a second
plurality of sub-layers is deposited on said second surface of said at least one
substrate/workpiece which collectively form a said uniform thickness layer of said
15 selected material.

15. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus
wherein said first and second groups of spaced-apart cathode target assemblies are
in substantial vertical registry; and

5 step (b) comprises substantially simultaneously forming a said uniform
thickness layer of said selected material on each of said first and second surfaces
of said at least one substrate/workpiece.

16. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus
wherein the cathode/target assemblies of said first and second groups of
cathode/target assemblies form an in-line or circular-shaped arrangement in a
5 single vacuum chamber.

17. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus
wherein the cathode/target assemblies of said first and second groups of
cathode/target assemblies are located in a plurality of vacuum chambers and said
5 plurality of vacuum chambers form an in-line or circular-shaped arrangement.

18. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus wherein each cathode/target assembly of said first and second groups of cathode/target assemblies is a planar magnetron cathode/target assembly
5 including a magnetron magnet means and the magnetron magnet means of at least some of said planar magnetron cathode/target assemblies are of different lengths, widths, or diameters.

19. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus wherein the sputtering surfaces of at least some cathode/target assemblies of said first and second groups of cathode/target assemblies are located at different
5 spacings from said first and second surfaces of said at least one substrate/workpiece.

20. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus wherein said means for transporting said at least one substrate/workpiece past each of said first and second groups of cathode/target assemblies comprises
5 means for mounting and transporting at least one disk-shaped substrate/workpiece.

21. The method according to claim 14, wherein:

step (a) comprises providing a multi-stage cathode sputtering apparatus further comprising shield means in spaced adjacency to the periphery of the sputtering surface of each cathode/target assembly.

22. The method according to claim 14, wherein:

step (b) comprises transporting at least one annular disk-shaped precursor substrate for a perpendicular magnetic recording medium past each cathode/target assembly of said first and second groups of cathode/target assemblies and forming

- 5 a magnetically soft underlayer (SUL) on said first and second surfaces of said precursor substrate as said uniform thickness layer of said selected material.

23. The method according to claim 22, wherein:

- step (b) comprises forming an about 500 to about 4,000 Å thick layer of a soft magnetic material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoZrNb, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, 5 FeSiAlN, FeCoB, FeCoC on said first and second surfaces of said at least one precursor substrate.